

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims

1 1. (currently amended) A method for sending data in a computer system,
2 comprising:
3 establishing a plurality of active direct memory access connections between the
4 host and a plurality of destinations;
5 establishing for each connection a Protocol Control Block, each Protocol Control
6 Block having a first window field, a virtual window field and a message limit field, for
7 the associated connection;
8 receiving from each destination a first window value representing a first quantity
9 of data packets for the connection associated with the destination, and storing the
10 received first window value in a first window field of the Protocol Control Block
11 associated with the connection;
12 for each Protocol Control Block, storing the value of a second quantity of data
13 packets in the virtual window field of the Protocol Control Block, wherein the second
14 quantity of each connection is less than the first window field value of the connection and
15 is based, at least in part, on the number of active connections of the host;
16 sending packets of data from said host to each destination;
17 receiving an acknowledgment from each destination for each packet of data
18 received by each destination wherein the first window value of each connection
19 represents a limit imposed on said host by the destination of the connection on the
20 quantity of data packets sent from said host to the destination of the connection and
21 lacking an acknowledgment of being received by the destination of the connection; and
22 limiting the number of packets sent by said host to each connection, but not
23 acknowledged as received by the destination of each connection, to the value of the
24 virtual window field of the Protocol Control Block associated with the connection,
25 wherein the value of the virtual window field of the Protocol Control Block associated
26 with the connection is less than the value of the first window field of the Protocol Control
27 Block associated with the connection;

28

29
30 ~~establishing an active connection adapted to send packets of data between a host~~
31 ~~and a destination;~~
32 ~~receiving from the destination a first window value representing a first quantity of~~
33 ~~data packets;~~
34 ~~sending packets of data from said host to said destination;~~
35 ~~receiving an acknowledgment from said destination for each packet of data~~
36 ~~received by said destination wherein said first window value represents a limit imposed~~
37 ~~on said host by said destination on the quantity of data packets sent from said host to said~~
38 ~~destination and lacking an acknowledgment of being received by destination;~~
39 ~~limiting the number of packets sent by said host, but not acknowledged as~~
40 ~~received by said destination, to a second quantity of data packets less than said first~~
41 ~~window value wherein said second quantity represents a limit imposed by said host on~~
42 ~~the quantity of data packets sent from said host to said destination and lacking an~~
43 ~~acknowledgment of being received by destination and wherein said second quantity is a~~
44 ~~function of the number of active connections of the host;~~
45 ~~establishing a plurality of active direct memory access connections between said~~
46 ~~host and a plurality of specified memory locations of a plurality of destinations;~~
47 ~~sending a plurality of messages to specified memory locations of the destinations~~
48 ~~of the direct memory access connections wherein each message comprises a plurality of~~
49 ~~data packets;~~
50 ~~receiving message acknowledgments, each message acknowledgment being sent~~
51 ~~by a destination for each message received by the destination; and~~
52 ~~for each connection, establishing a message limit and storing the value of the~~
53 ~~message limit in the message limit field of the Protocol Control Block associated with the~~
54 ~~connection; and~~
55 ~~for each connection, limiting the number of messages sent by said host through~~
56 ~~the connection, but not acknowledged as received by the destination of the connection, to~~
57 ~~the value of the message limit field of the Protocol Control Block associated with the~~
58 ~~connection so that establishing a plurality of message limits; each message limit~~
59 ~~imposes~~ ~~imposes~~ a separate limit for each direct memory access connection on the
60 quantity of messages sent from said host to the specified memory location of the direct
61 memory access connection associated with the message limit and lacking a message

62 acknowledgment of being received by the destination of the direct memory access
63 connection associated with the message limit, each message limit providing a further
64 limit on the associated connection in addition to the packet limit imposed by the value of
65 the virtual window field of the Protocol Control Block associated with the connection.
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1 2. (currently amended) The method of claim 1 wherein ~~the~~ each active direct
2 memory access connection ~~is~~ includes a Transmission Control Protocol connection
3 between the host and the destination and wherein said first window value is a
4 Transmission Control Protocol send window value.

1 3. (cancelled)

1 4. (cancelled)

1 5. (currently amended) The method of claim 2 ~~3~~ further comprising,
2 in response to the destination reducing the size of the Transmission Control
3 Protocol send window value to a third quantity less than the second quantity, limiting the
4 number of packets sent by said host, but not acknowledged as received by said
5 destination, to a fourth quantity of data packets no greater than the reduced size of the
6 Transmission Control Protocol send window value; and
7 storing the value of the fourth quantity of data packets in the virtual window field
8 of the associated Protocol Control Block.

1 6. (cancelled)

1 7. (previously presented) The method of claim 1, wherein each direct memory
2 access connection includes a network interface between an application of said host and a
3 network connecting the host to the plurality of destinations and wherein said network
4 interface includes a queue for each direct memory access connection and adapted to
5 queue messages to be sent through the direct memory access connection associated with
6 each queue, and wherein said each sending of a message to specified memory location of
7 the destination of a direct memory access connection includes queuing the message in the
8 network interface queue associated with the direct memory access connection; and

9 wherein the queuing of messages in the network interface queue associated with a direct
10 memory access connection is suspended when the quantity of messages sent from said
11 host to the specified memory location of the associated direct memory access connection
12 and lacking a message acknowledgment of being received by the destination of the
13 associated direct memory access connection reaches the separate message limit imposed
14 on the direct memory access connection associated with the network interface queue.

1 8. (original) The method of claim 7, wherein the queuing of messages in the
2 network interface queue associated with a direct memory access connection is resumed
3 when the quantity of messages sent from said host to the specified memory location of
4 the associated direct memory access connection and lacking a message acknowledgment
5 of being received by the destination of the associated direct memory access connection is
6 less than the separate message limit imposed on the direct memory access connection
7 associated with the network interface queue.

1 9. (currently amended) The method of claim 8 wherein each active direct
2 memory access connection includes a Transmission Control Protocol connection
3 between the host and the destination and wherein said first window value is a
4 Transmission Control Protocol send window value ~~the packet sending connection is a~~
5 ~~Transmission Control Protocol connection between the host and the destination and~~
6 wherein each direct memory access connection is a Remote Direct Memory Access
7 connection between the host and the destination of the direct memory access connection
8 and each message is a Remote Direct Memory Access message.

1 10. (previously presented) The method of claim 9 wherein said network interface
2 has a pool of empty messages which imposes a limit on the total quantity of messages
3 sent from said host to all the specified memory locations of all the direct memory access
4 connections and lacking a message acknowledgment of being received by the destination
5 of the associated direct memory access connection and wherein each message limit is less
6 than the network interface pool of empty messages.

1 11. (currently amended) The method of claim 1 6 wherein each message limit is
2 based, at least in part, on the number of active direct memory access connections of the
3 host.

1 12. (currently amended) The method of claim 1 6 further comprising changing
2 the size of a message limit of an active direct memory access connection prior to sending
3 at least one message through the associated direct memory access connection.

1 13. (currently amended) The method of claim 12 6 wherein each message limit
2 is based, at least in part, on the number of active direct memory access connections of the
3 host.

1 14. (previously presented) The method of claim 1 further comprising changing
2 the size of the second quantity of packets limiting the number of packets sent by the host
3 but not acknowledged as received by the destination prior to sending at least one packet.

1 15. (currently amended) A system adapted to communicate with data storage and
2 a destination having memory locations, comprising:

3 a system memory;

4 a processor coupled to the system memory;

5 a network adaptor;

6 a data storage controller for managing Input/Output (I/O) access to the data
7 storage; and

8 a device driver executable by the processor in the memory, wherein at least one of
9 the device driver and the network adaptor is adapted to:

10 establish a plurality of active direct memory access connections between
11 the system and a plurality of destinations;

12 establish for each connection a Protocol Control Block, each Protocol
13 Control Block having a first window field, a virtual window field and a message limit
14 field, for the associated connection;

15 receive from each destination a first window value representing a first
16 quantity of data packets for the connection associated with the destination, and store the
17 received first window value in a first window field of the Protocol Control Block
18 associated with the connection;

19 for each Protocol Control Block, store the value of a second quantity of
20 data packets in the virtual window field of the Protocol Control Block, wherein the
21 second quantity of each connection is less than the first window field value of the

22 connection and is based, at least in part, on the number of active connections of the
23 system;

24 send packets of data from said system to each destination;
25 receive an acknowledgment from each destination for each packet of data
26 received by each destination wherein the first window value of each connection
27 represents a limit imposed on said system by the destination of the connection on the
28 quantity of data packets sent from said system to the destination of the connection and
29 lacking an acknowledgment of being received by the destination of the connection; and
30 limit the number of packets sent by said system to each connection, but
31 not acknowledged as received by the destination of each connection, to the value of the
32 virtual window field of the Protocol Control Block associated with the connection,
33 wherein the value of the virtual window field of the Protocol Control Block associated
34 with the connection is less than the value of the first window field of the Protocol Control
35 Block associated with the connection;

36
37 (i) establish an active connection adapted to send packets of data between
38 the system and a destination;

39 (ii) receive from a destination a first window value representing a first
40 quantity of data packets;

41 (iii) send packets of data from the system to said destination;

42 (iv) receive an acknowledgment from said destination for each packet of
43 data received by said destination wherein said first window value represents a
44 limit imposed on said system by said destination on the quantity of data packets
45 sent from said system to said destination and lacking an acknowledgment of being
46 received by destination;

47 (v) limit the number of packets sent by said system, but not acknowledged as
48 received by said destination, to a second quantity of data packets less than said first
49 quantity wherein said second quantity represents a limit imposed by said system on the
50 quantity of data packets sent from said system to said destination and lacking an
51 acknowledgment of being received by destination and wherein said second quantity is a
52 function of the number of active connections of the system;

53 (vi) establish a plurality of active direct memory access connections between said
54 host and a plurality of specified memory locations of a plurality of destinations;

(vii) send a plurality of messages to specified memory locations of the destinations of the direct memory access connections wherein each message comprises a plurality of data packets;

(viii) receive message acknowledgments, each message acknowledgment being sent by a destination for each message received by the destination; and

for each connection, establish a message limit and store the value of the message limit in the message limit field of the Protocol Control Block associated with the connection; and

for each connection, limit the number of messages sent by said system through the connection, but not acknowledged as received by the destination of the connection, to the value of the message limit field of the Protocol Control Block associated with the connection so that (ix) establish a plurality of message limits; each message limit imposing imposes a separate limit for each direct memory access connection on the quantity of messages sent from said system host to the specified memory location of the direct memory access connection associated with the message limit and lacking a message acknowledgment of being received by the destination of the direct memory access connection associated with the message limit, each message limit providing a further limit on the associated connection in addition to the packet limit imposed by the value of the virtual window field of the Protocol Control Block associated with the connection.

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16. (original) The system of claim 15, wherein the data storage comprises a magnetic storage medium.

17. (currently amended) The system of claim 15, wherein each active direct memory access the connection ~~is~~ includes a Transmission Control Protocol connection between the system and the destination and wherein said first window value is a Transmission Control Protocol send window value.

18. (cancelled)

19. (cancelled)

1 20. (currently amended) The system of claim 17 49 wherein at least one of the
2 device driver and the network adaptor is adapted to:
3 in response to the destination reducing the size of the Transmission Control
4 Protocol send window value to a third quantity less than the second quantity, limiting
5 limit the number of packets sent by said system, but not acknowledged as received by
6 said destination, to a fourth quantity of data packets no greater than the reduced size of
7 the Transmission Control Protocol send window value; and
8 store the value of the fourth quantity of data packets in the virtual window field of
9 the associated Protocol Control Block.

1 21. (cancelled)

1 22. (previously presented) The system of claim 15 , wherein at least one of the
2 device driver and the network adaptor is adapted to provide a queue for each direct
3 memory access connection and adapted to queue messages to be sent through the direct
4 memory access connection associated with each queue, and wherein in each sending of a
5 message to specified memory location of the destination of a direct memory access
6 connection, at least one of the device driver and the network adaptor is adapted to queue
7 the message in the queue associated with the direct memory access connection; and to
8 suspend the queuing of messages in the queue associated with a direct memory access
9 connection when the quantity of messages sent from said system to the specified memory
10 location of the associated direct memory access connection and lacking a message
11 acknowledgment of being received by the destination of the associated direct memory
12 access connection reaches the separate message limit imposed on the direct memory
13 access connection associated with the queue.

1 23. (original) The system of claim 22, wherein at least one of the device driver
2 and the network adaptor is adapted to resume the queuing of messages in the queue
3 associated with a direct memory access connection when the quantity of messages sent
4 from said system to the specified memory location of the associated direct memory
5 access connection and lacking a message acknowledgment of being received by the
6 destination of the associated direct memory access connection is less than the separate
7 message limit imposed on the direct memory access connection associated with the
8 network interface queue.

1 24. (currently amended) The system of claim 23 wherein each active direct
2 memory access connection includes a Transmission Control Protocol connection
3 between the host and the destination and wherein said first window value is a
4 Transmission Control Protocol send window value ~~the packet-sending connection is a~~
5 ~~Transmission Control Protocol connection between the system and the destination of the~~
6 ~~packet-sending connection~~ and wherein each direct memory access connection is a
7 Remote Direct Memory Access connection between the system and the destination of the
8 direct memory access connection and each message is a Remote Direct Memory Access
9 message.

1 25. (original) The system of claim 24 wherein at least one of the device driver
2 and the network adaptor is adapted to provide a pool of empty messages which imposes a
3 limit on the total quantity of messages sent from said system to all the specified memory
4 locations of all the direct memory access connections and lacking a message
5 acknowledgment of being received by the destination of the associated direct memory
6 access connection and wherein each message limit is less than the pool of empty
7 messages.

1 26. (currently amended) An article of manufacture comprising a computer
2 readable storage medium having code executed by a processor for managing data
3 transmission through a network, wherein the article of manufacture causes operations to
4 be performed, the operations comprising:

5 establishing a plurality of active direct memory access connections between the
6 host and a plurality of destinations;

7 establishing for each connection a Protocol Control Block, each Protocol Control
8 Block having a first window field, a virtual window field and a message limit field, for
9 the associated connection;

10 receiving from each destination a first window value representing a first quantity
11 of data packets for the connection associated with the destination, and storing the
12 received first window value in a first window field of the Protocol Control Block
13 associated with the connection;

14 for each Protocol Control Block, storing the value of a second quantity of data
15 packets in the virtual window field of the Protocol Control Block, wherein the second

16 quantity of each connection is less than the first window field value of the connection and
17 is based, at least in part, on the number of active connections of the host;
18 sending packets of data from said host to each destination;
19 receiving an acknowledgment from each destination for each packet of data
20 received by each destination wherein the first window value of each connection
21 represents a limit imposed on said host by the destination of the connection on the
22 quantity of data packets sent from said host to the destination of the connection and
23 lacking an acknowledgment of being received by the destination of the connection; and
24 limiting the number of packets sent by said host to each connection, but not
25 acknowledged as received by the destination of each connection, to the value of the
26 virtual window field of the Protocol Control Block associated with the connection,
27 wherein the value of the virtual window field of the Protocol Control Block associated
28 with the connection is less than the value of the first window field of the Protocol Control
29 Block associated with the connection;
30 establishing an active connection adapted to send packets of data between a host
31 and a destination;
32 receiving from a destination a first window value representing a first quantity of
33 data packets;
34 sending packets of data from a host to said destination;
35 receiving an acknowledgment from said destination for each packet of data
36 received by said destination wherein said first window value represents a limit imposed
37 on said host by said destination on the quantity of data packets sent from said host to said
38 destination and lacking an acknowledgment of being received by destination;
39 limiting the number of packets sent by said host, but not acknowledged as
40 received by said destination, to a second quantity of data packets less than said first
41 quantity wherein said second quantity represents a limit imposed by said host on the
42 quantity of data packets sent from said host to said destination and lacking an
43 acknowledgment of being received by destination and wherein said second quantity is a
44 function of the number of active connections of the host;
45 establishing a plurality of active direct memory access connections between said
46 host and a plurality of specified memory locations of a plurality of destinations;

47 sending a plurality of messages to specified memory locations of the destinations
48 of the direct memory access connections wherein each message comprises a plurality of
49 data packets;
50 receiving message acknowledgments, each message acknowledgment being sent
51 by a destination for each message received by the destination; and
52 for each connection, establishing a message limit and storing the value of the
53 message limit in the message limit field of the Protocol Control Block associated with the
54 connection; and
55 for each connection, limiting the number of messages sent by said host through
56 the connection, but not acknowledged as received by the destination of the connection, to
57 the value of the message limit field of the Protocol Control Block associated with the
58 connection so that establishing a plurality of message limits; each message limit
59 ~~imposing~~ imposes a separate limit for each direct memory access connection on the
60 quantity of messages sent from said host to the specified memory location of the direct
61 memory access connection associated with the message limit and lacking a message
62 acknowledgment of being received by the destination of the direct memory access
63 connection associated with the message limit, each message limit providing a further
64 limit on the associated connection in addition to the packet limit imposed by the value of
65 the virtual window field of the Protocol Control Block associated with the connection.

1 27. (currently amended) The article of manufacture of claim 26 wherein ~~the each~~
2 active direct memory access connection is includes a Transmission Control Protocol
3 connection between the host and the destination and wherein said first window value is a
4 Transmission Control Protocol send window value.

1 28. (cancelled)

1 29. (cancelled-)

1 30. (currently amended) The article of manufacture of claim ~~27~~ 28, wherein the
2 operations further comprise:
3 in response to the destination reducing the size of the Transmission Control
4 Protocol send window value to a third quantity less than the second quantity, limiting the
5 number of packets sent by said host, but not acknowledged as received by said

6 destination, to a fourth quantity of data packets no greater than the reduced size of the
7 Transmission Control Protocol send window value; and
8 storing the value of the fourth quantity of data packets in the virtual window field
9 of the associated Protocol Control Block.

1 31. (cancelled)

1 32. (previously presented) The article of manufacture of claim 26, wherein each
2 direct memory access connection includes a network interface between an application of
3 said host and a network connecting the host to the plurality of destinations and wherein
4 said network interface includes a queue for each direct memory access connection and
5 adapted to queue messages to be sent through the direct memory access connection
6 associated with each queue, and wherein said each sending of a message to specified
7 memory location of the destination of a direct memory access connection includes
8 queuing the message in the network interface queue associated with the direct memory
9 access connection; and wherein the queuing of messages in the network interface queue
10 associated with a direct memory access connection is suspended when the quantity of
11 messages sent from said host to the specified memory location of the associated direct
12 memory access connection and lacking a message acknowledgment of being received by
13 the destination of the associated direct memory access connection reaches the separate
14 message limit imposed on the direct memory access connection associated with the
15 network interface queue.

1 33. (original) The article of manufacture of claim 32, wherein the queuing of
2 messages in the network interface queue associated with a direct memory access
3 connection is resumed when the quantity of messages sent from said host to the specified
4 memory location of the associated direct memory access connection and lacking a
5 message acknowledgment of being received by the destination of the associated direct
6 memory access connection is less than the separate message limit imposed on the direct
7 memory access connection associated with the network interface queue.

1 34. (currently amended) The article of manufacture of claim 33 wherein each
2 active direct memory access connection includes a Transmission Control Protocol
3 connection between the host and the destination and wherein said first window value is a

4 ~~Transmission Control Protocol send window value the packet sending connection is a~~
5 ~~Transmission Control Protocol connection between the host and the destination and~~
6 wherein each direct memory access connection is a Remote Direct Memory Access
7 connection between the host and the destination of the direct memory access connection
8 and each message is a Remote Direct Memory Access message.

1 35. (original) The article of manufacture of claim 34 wherein said network
2 interface has a pool of empty messages which imposes a limit on the total quantity of
3 messages sent from said host to all the specified memory locations of all the direct
4 memory access connections and lacking a message acknowledgment of being received by
5 the destination of the associated direct memory access connection and wherein each
6 message limit is less than the network interface pool of empty messages.

1 36. (previously presented) The article of manufacture of claim 26 wherein each
2 message limit is based, at least in part, on the number of active direct memory access
3 connections of the host.

1 37. (currently amended) The article of manufacture of claim ~~26~~ 34 further
2 comprising changing the size of a message limit of an active direct memory access
3 connection prior to sending at least one message through the associated direct memory
4 access connection.

1 38. (previously presented) The article of manufacture of claim 37 wherein each
2 message limit is based, at least in part, on the number of active direct memory access
3 connections of the host.

1 39. (previously presented) The article of manufacture of claim 26 further
2 comprising changing the size of the second quantity of packets limiting the number of
3 packets sent by the host but not acknowledged as received by the destination prior to
4 sending at least one packet.